ECE 201 Spring 2010

Homework 17 Solutions

Problem 27

(a)

Let V be the common voltage across C_1 and C_2. Thus

$$\begin{aligned}(C_1+C_2)\frac{dV}{dt} &= i_s(t)\\ C_2\frac{dV}{dt} &= i_{C2}(t)\\ \Rightarrow i_{C2}(t) &= \frac{C_2}{C_1+C_2}i_s(t)\end{aligned}$$

(b)

Using KVL across the second loop and relation from part (a), we get

$$\begin{aligned}r_m i_{C2}(t)-(L_1+L_2)\frac{di}{dt} &= 0\\ v_{out}(t) &= L_2\frac{di}{dt}\\ &= r_m\frac{L_2C_2}{(L_1+L_2)(C_1+C_2)}i_s(t)\end{aligned}$$

Problem 38

(a)

Starting from the right end and combining the inductors in series and parallel consecutively, we get L_{eq} as

$$\begin{aligned}L_{eq} &= 4+((36)||(10+((1+5)||(3))))\\ &= 4+((36)||(10+((6)||(3))))\end{aligned}$$

$$
\begin{aligned}
&= 4 + ((36)||(10 + (2))) \\
&= 4 + ((36)||(12)) \\
&= 4 + 9 \\
&= 13\ mH
\end{aligned}
$$

(b)

Clearly, the given circuit has 1.2 mH and 0.6 mH in parallel, and this combination is in series with 2.4 mH, the equivalent of which is in parallel with 7 mH. Thus

$$
\begin{aligned}
L_{eq} &= 7||(2.4 + (1.2||0.6)) \\
&= 7||(2.4 + 0.4) \\
&= 7||2.8 \\
&= 2\ mH
\end{aligned}
$$

Problem 41

(a)

Remember that the equivalent capacitance expressions for series and parallel connections are opposite of that used for resistances. The equivalent capacitance can be written as

$$
\begin{aligned}
C_{eq} &= C_1||(C_2 + (C_3||C_4)) \\
&= 4 + \frac{6 \times 3}{9} \\
&= 6\ \mu F \\
v_s(t) &= \frac{1}{C_{eq}} \int_{-\infty}^{t} i_s(\tau)\, d\tau \\
&= \frac{1}{6} \sin(10^4 t)\ V
\end{aligned}
$$

(b)

$$
C_{eq} = C_1||(C_2 + (C_3||C_4) + C_5)
$$

$$
\begin{aligned}
(C_2 + (C_3 || C_4) + C_5) &= \left(\frac{1}{18} + \frac{1}{54} + \frac{1}{10.8}\right)^{-1} \\
&= 6\ \mu F \\
\Rightarrow C_{eq} &= 6 + 60 \\
&= 66\ \mu F \\
v_s(t) &= \frac{1}{C_{eq}} \int_{-\infty}^{t} i_s(\tau)\, d\tau \\
&= \frac{1}{660}(1 - \cos(10^5 t))\ V
\end{aligned}
$$